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Abstract

ADVANCES IN RADIOISOTOPE PRODUCTION AND UTILIZATION IN SCIENCE AND INDUSTRY

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Now, only three decades after the discovery that radioactivity could be artificially induced, man-made radioisotopes have been established as powerful and versatile tools for an almost countless number of uses in nearly all fields of research and application. Man-made radioactivity is truly one of those discoveries of major benefit to mankind.

Advances in the discovery and production of specific radionuclides have been phenomenal. Although around 130 radioactive species have received significant usage and are routinely produced, the potential number of useful radioisotopes is much greater. Means of production cover a variety of accelerators with great flexibility in type and energy of particles and radiation generated, encompassing the use of photons, neutrons, protons, deuterons, tritons, helium-3 and alpha particles and heavier nuclei. However, the bulk production of radioactivity is now by means of nuclear reactors. Through neutron bombardment in high-flux high-power reactors, production of most useful isotopes can be expanded to meet any conceivable need, up to hundreds of megacuries of certain isotopes such as cobalt-60. Also, vast quantities of fission products are unavoidably obtained as by-products of power and/or plutonium production. Individual radioisotopes from this source are being separated and purified in megacurie quantities. Costs of production have been greatly reduced and could

become even lower with larger demand.

Advances in radiation detectors, associated electronics technology and the automatic recording and analysis of data also have been astonishing. Use of solid scintillation counters has become routine, and crystals are available in various shapes and sizes up to 16 inches in diameter. Liquid scintillation counting has become extensively employed for efficient internal particle counting of a broad variety of sample forms. Use of liquid, plastic, and crystal detectors, with associated circuitry involving multi-channel pulse-height analysis, coincidence and/or anti-coincidence techniques, has been extended to extremely low-level counting of samples, even to the size of human beings. Recently, a variety of semi-conductor detectors have been developed that provide increased energy resolution for counting alpha particles, conversion electrons and low energy X and gamma rays. Semi-conductor detectors incorporating heavier elements are under development to permit efficient high-resolution counting of higher-energy gamma rays.

Parallel improvements and expansion in utilization of radioisotopes have taken place rapidly in all fields of application. In the basic physical sciences, the major applications are for analytical techniques, determination of molecular structure, measurement of reaction kinetics and determination of physical properties and behavior of matter. In the applied sciences, new uses are being developed in engineering and such fields as oceanography, meteorology, hydrology, other geosciences and space technology. Estimates will be presented on the increasing scope and benefits of use throughout the world in science and industry. Undeveloped potentials will be highlighted.